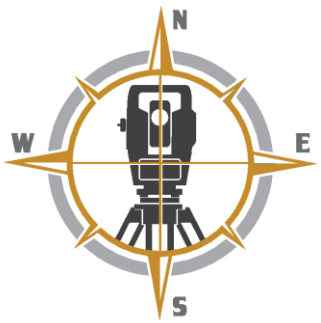
جامعة الأمير مقرن بن عبد العزيز
University of Prince Mugrin

AE 475 - Surveying

Week . 6

ANGLES AND DIRECTIONS



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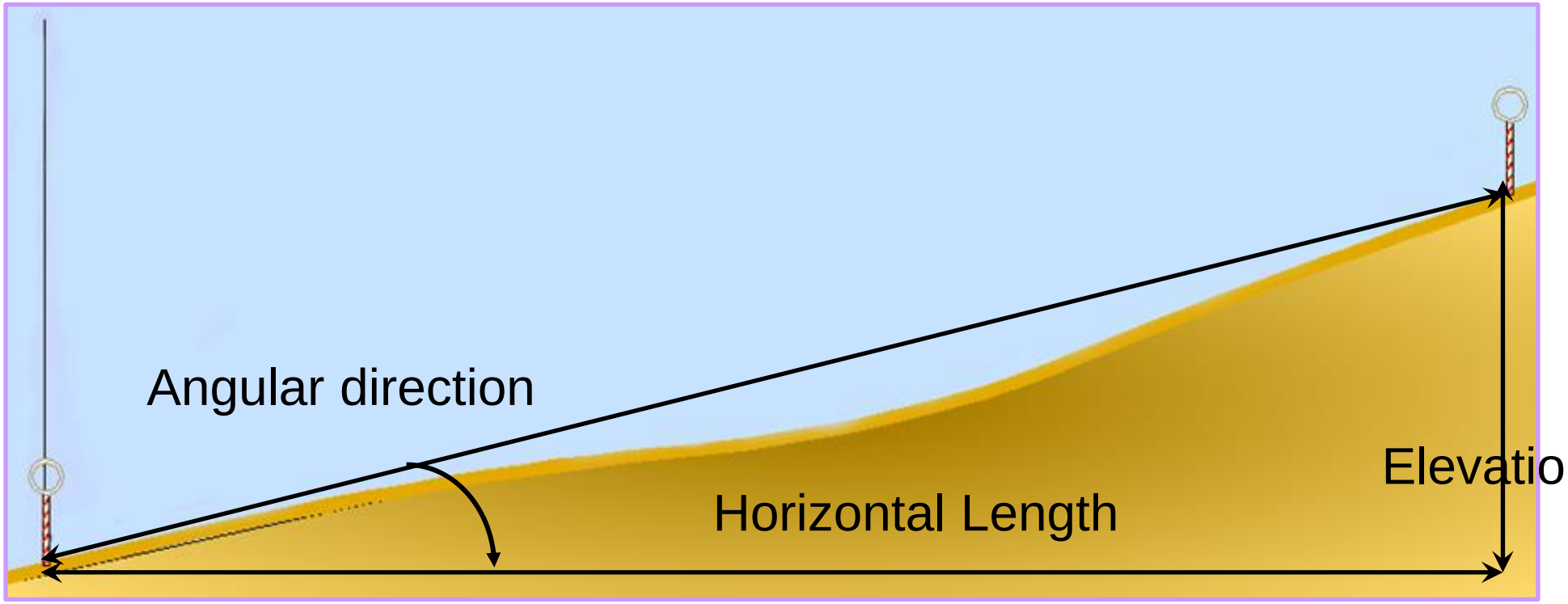
Introduction

To locate an object with reference to a known position, you need:,

(1) Horizontal length

(2) Difference in height (elevation)

(3) Angular direction

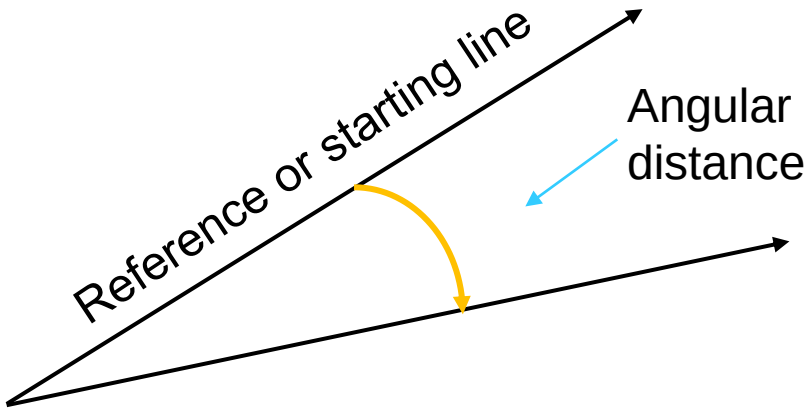


Introduction

An angle is defined as the difference in direction between two convergent lines.

Angles measured in surveying are classified as either horizontal or vertical, depending on the plane in which they are observed

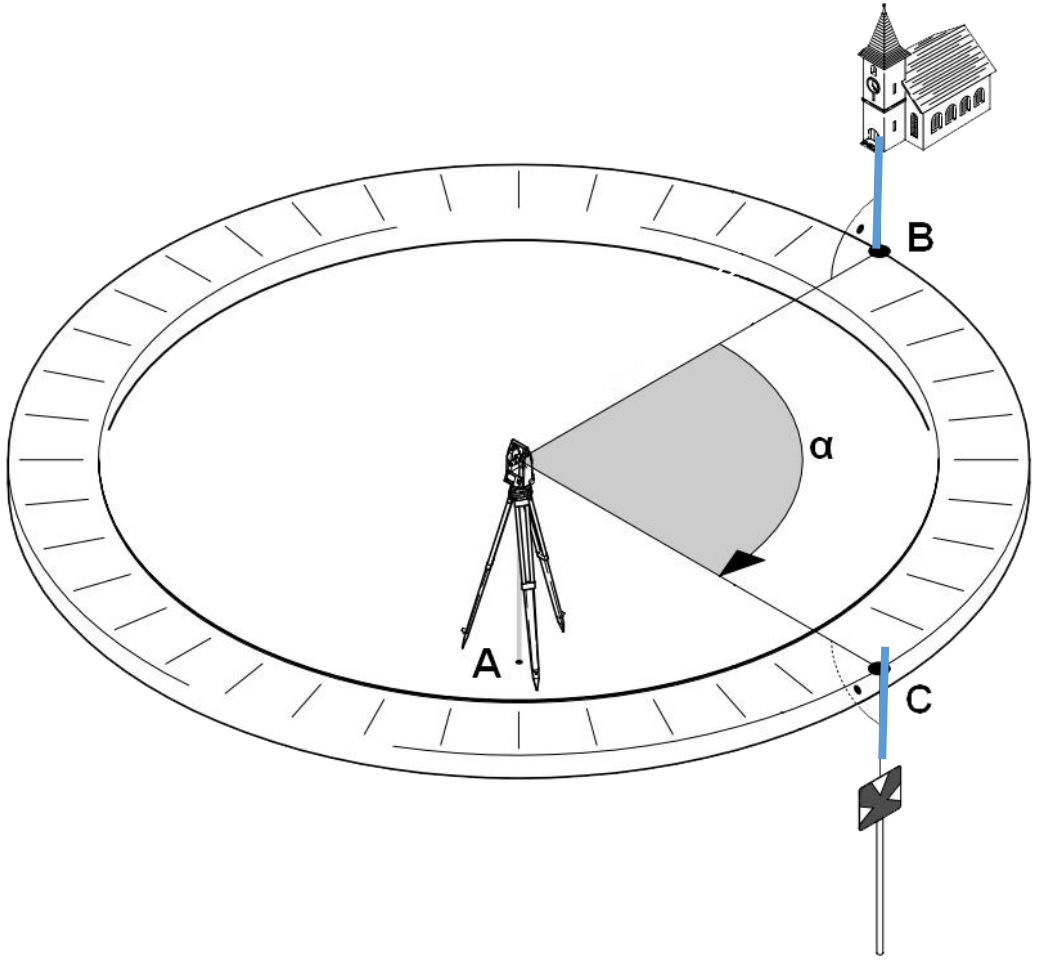
The instrument used in the measurement of angles is called a Theodolite



Horizontal Angle

A Horizontal angle is formed by the directions to two objects in a horizontal Plane.

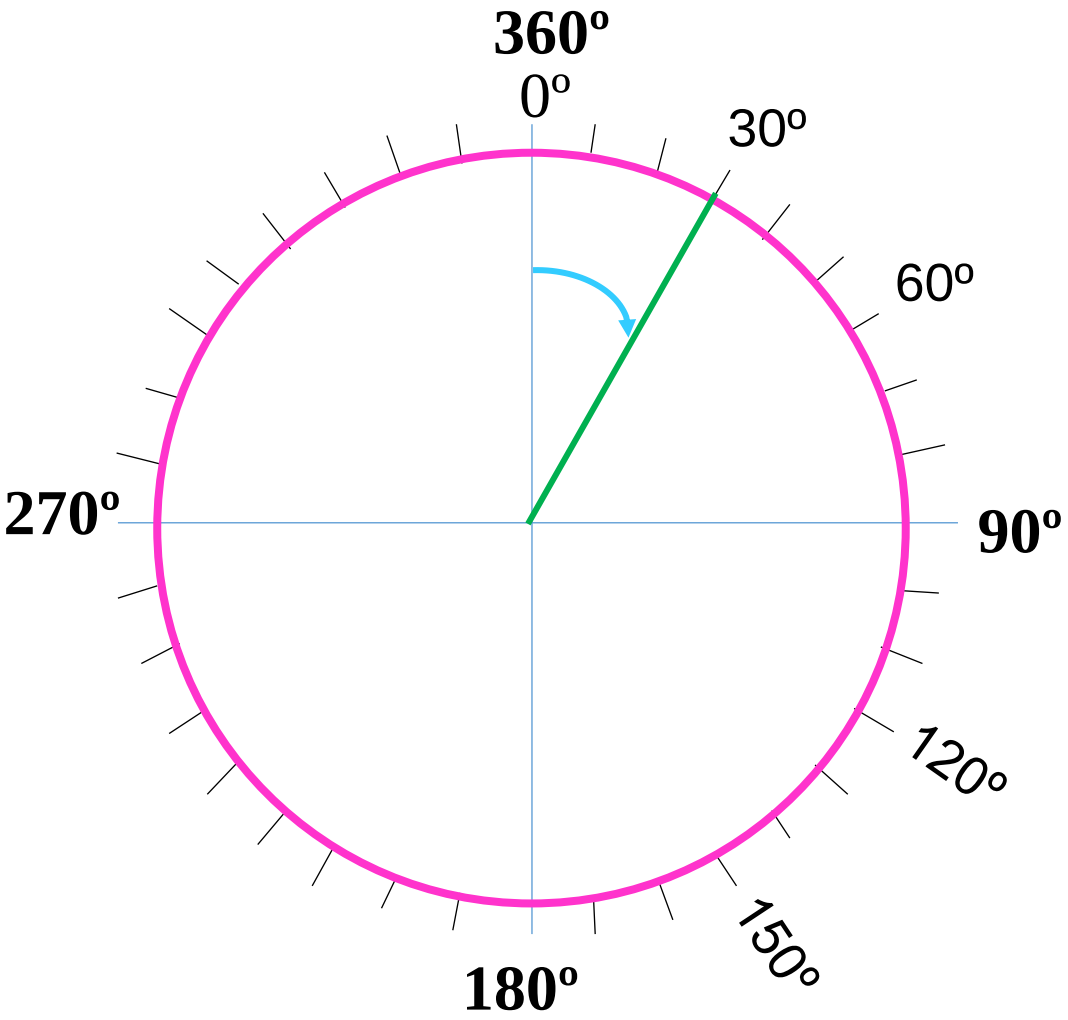
- It is used primarily to obtain relative direction to a survey control point, or to topographic detail points, or to points to be set out.

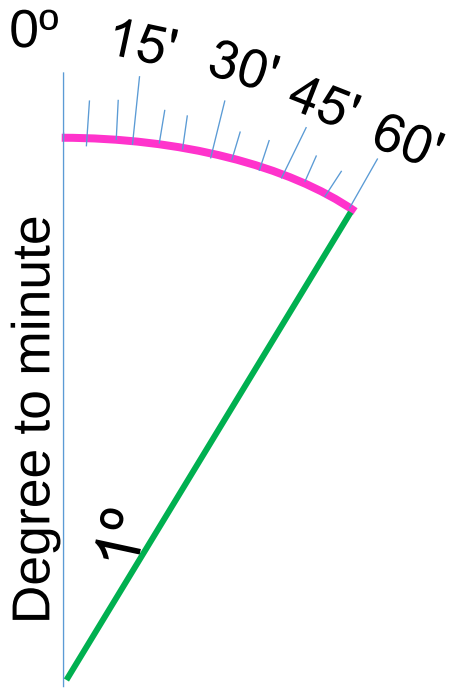


- Horizontal angles are usually measured with a **Theodolite** or **Totalstation** whose precision usually ranges from 1 to 20 seconds of arc.

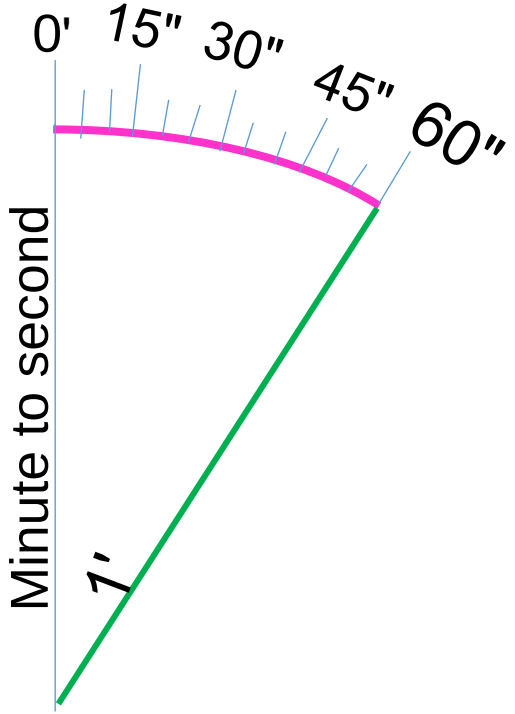
Units of angular measurement

The sexagesimal system is usually used, which it uses angular notation in increments of 60 by dividing the circle into 360 degrees; degrees into 60 minutes; and minutes into 60 seconds.





1 Degrees



1 Minute

Types of horizontal angles

I. Interior Angles:

For all closed polygons of *n* sides, the sum of the interior angles will be:

Sum of interior angles = $(n - 2) \times 180°$

Example:

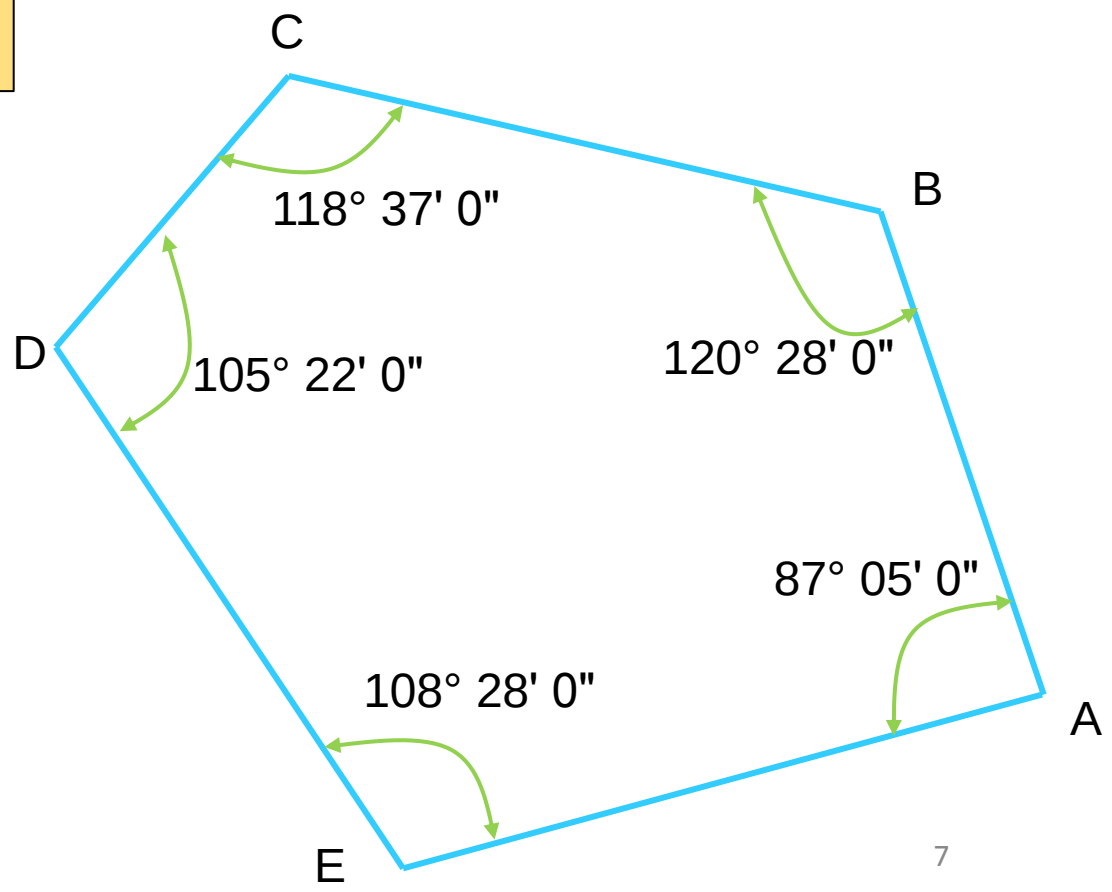
For a five-sided polygon, the sum of the interior angles must be:

$n = 5$

$(5 - 2) \times 180 = 3 \times 180 = 540$

87 ° 05 ' 0 "
120 ° 28 ' 0 "
118 ° 37 ' 0 "
105 ° 22 ' 0 "
108 ° 28 ' 0 "

$\sum$ = **540 ° 0 ' 0 "**



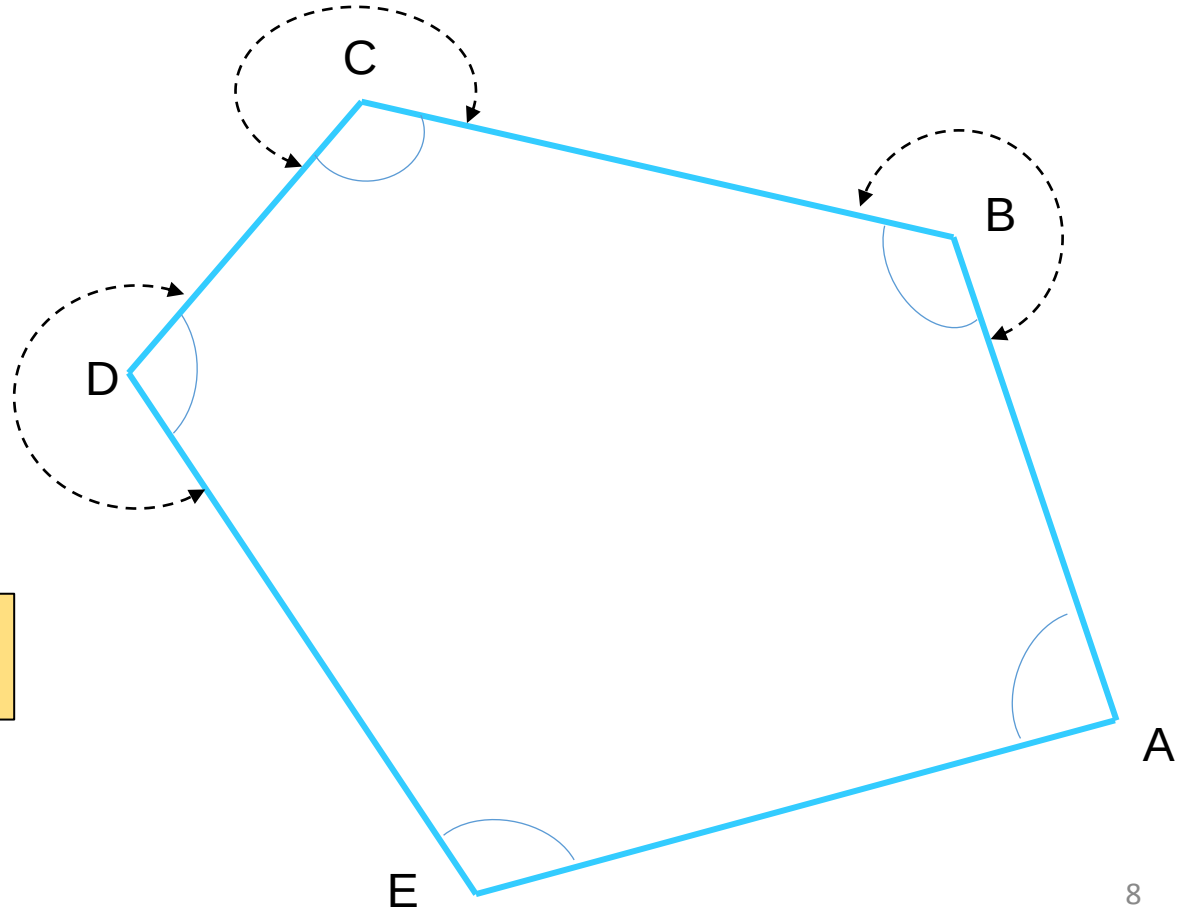
Types of horizontal angles

II. Exterior Angles:

Generally, exterior angles are measured only occasionally to serve as a check on the interior angle.

Exterior angle = 360 − Interior angle

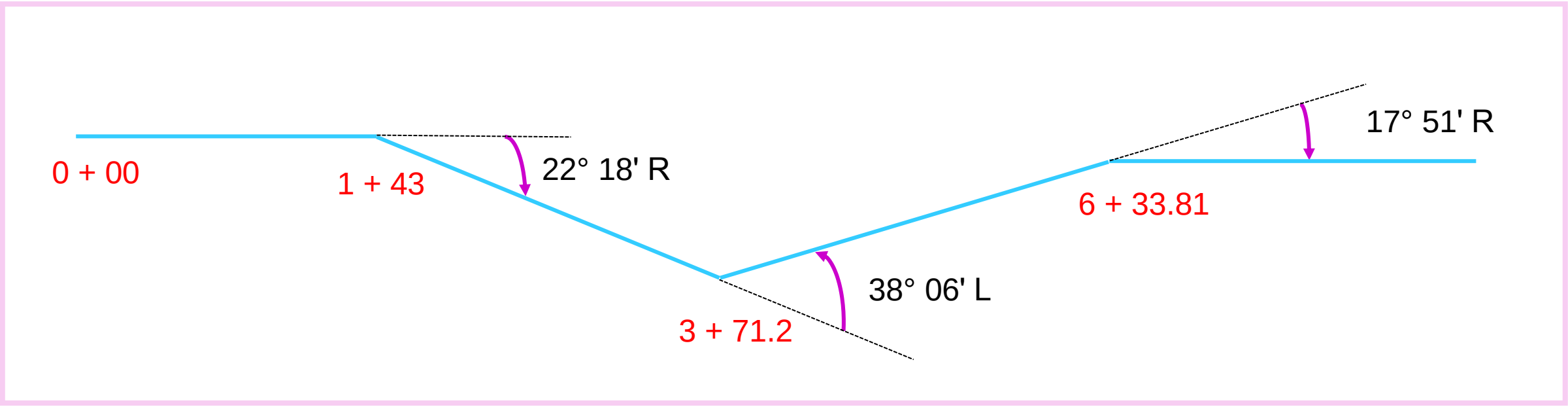
Sum of exterior angles **= (*n* + 2) × 180°**



Types of horizontal angles

III. Deflection Angles:

Deflection angles is a horizontal angle that observed from an extension of the back line to the forward station. They are used principally on the long linear alignments of route surveys.

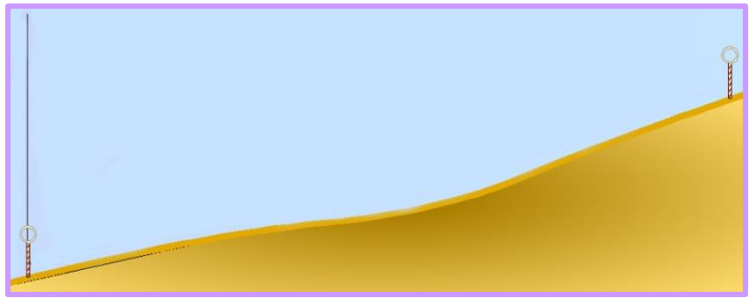


- Deflection angles are always smaller than 180°
- The deflection angles must be clearly identified as being turned either to the left (counterclockwise) or to the right (clockwise), using the letters L or R, respectively
- Deflection angles are commonly measured during open traverse or route surveys, such as for a highway.

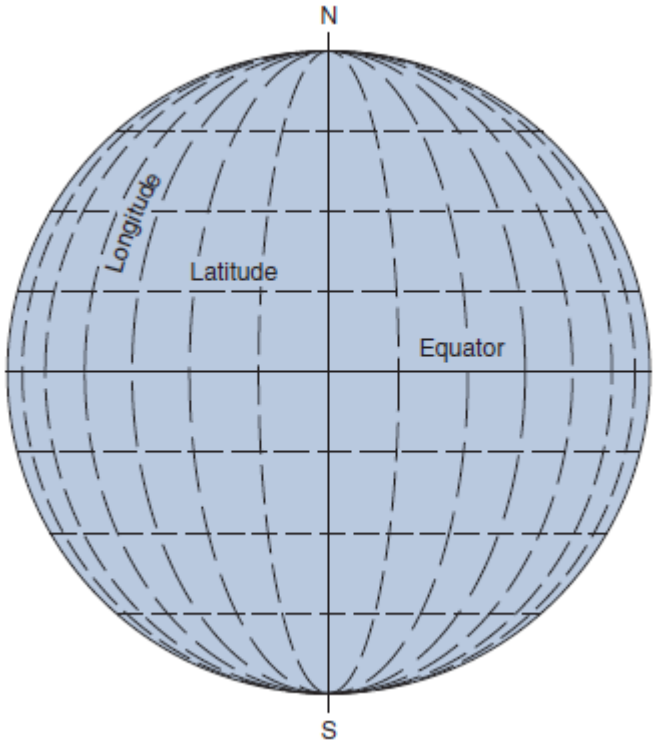
DIRECTIONS

SURVEY GEOGRAPHIC REFERENCE

- Surveying involves measuring the location of physical land features relative to one another

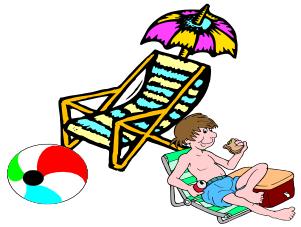


- Also it can be relative to a defined reference on the surface of the earth.
- The earth's reference system is composed of the surface divisions denoted by geographic lines of latitude and longitude



Positioning on the Earth's Surface

East is the direction of rotation of the Earth



Latitude: (90°N to 90°S)

Longitude: (180°E to 180°W)

Prime Meridian

0° Longitude

Tropic of Cancer

21st June

22nd Sept

Equator

20th March

22nd December

Tropic of Capricorn

Latitude $23\frac{1}{2}°$ North

$90°$ $66\frac{1}{2}°$ $23\frac{1}{2}°$

$90°$ $23\frac{1}{2}°$

Latitude 0°

Latitude $23\frac{1}{2}°$ South

Longitude 90° West

Longitude 60° West

Longitude 30° West

Longitude 90°East

Longitude 60° East

Longitude 30° East

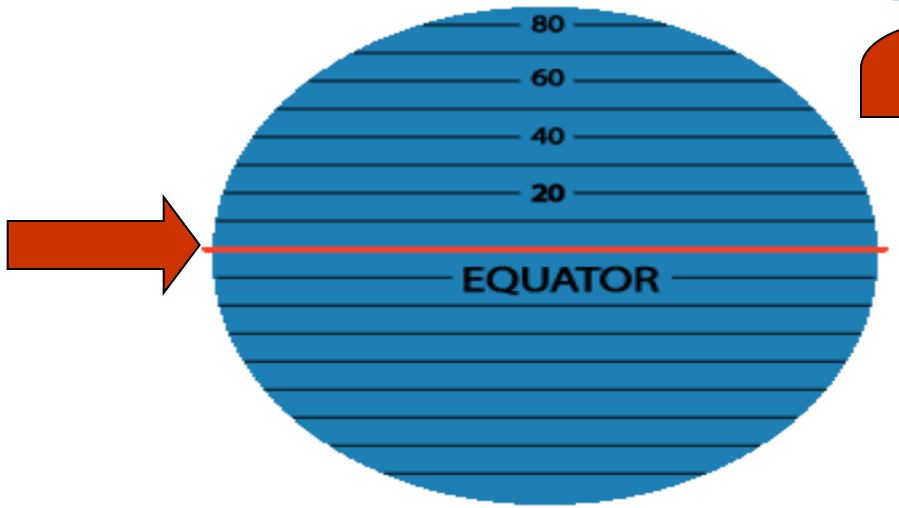
South Pole

Latitude and Longitude together enable the fixing of position on the Earth's surface.

Latitude

The North Pole is at 90° N

The equator is at 0° latitude. It is neither north nor south. It is at the center between north and south.



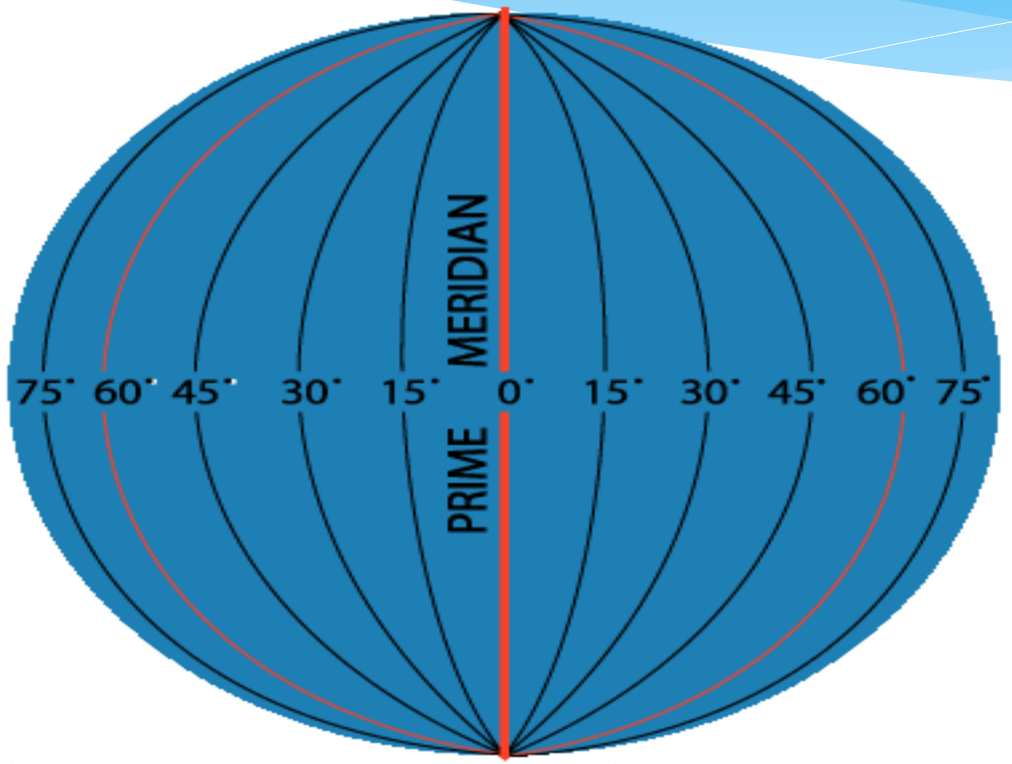
40° N is the 40° line of latitude north of the equator.

40° S is the 40° line of latitude south of the equator.

Longitude

Lines of longitude begin at the Prime Meridian.

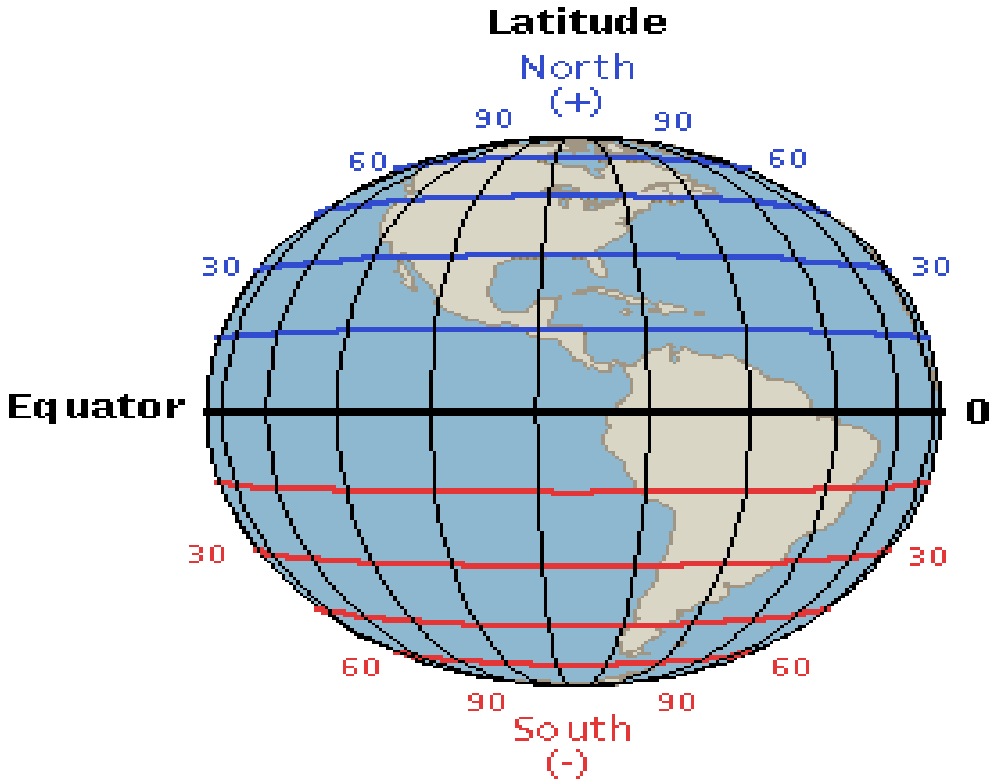
60° W is the 60° line of longitude west of the Prime Meridian.

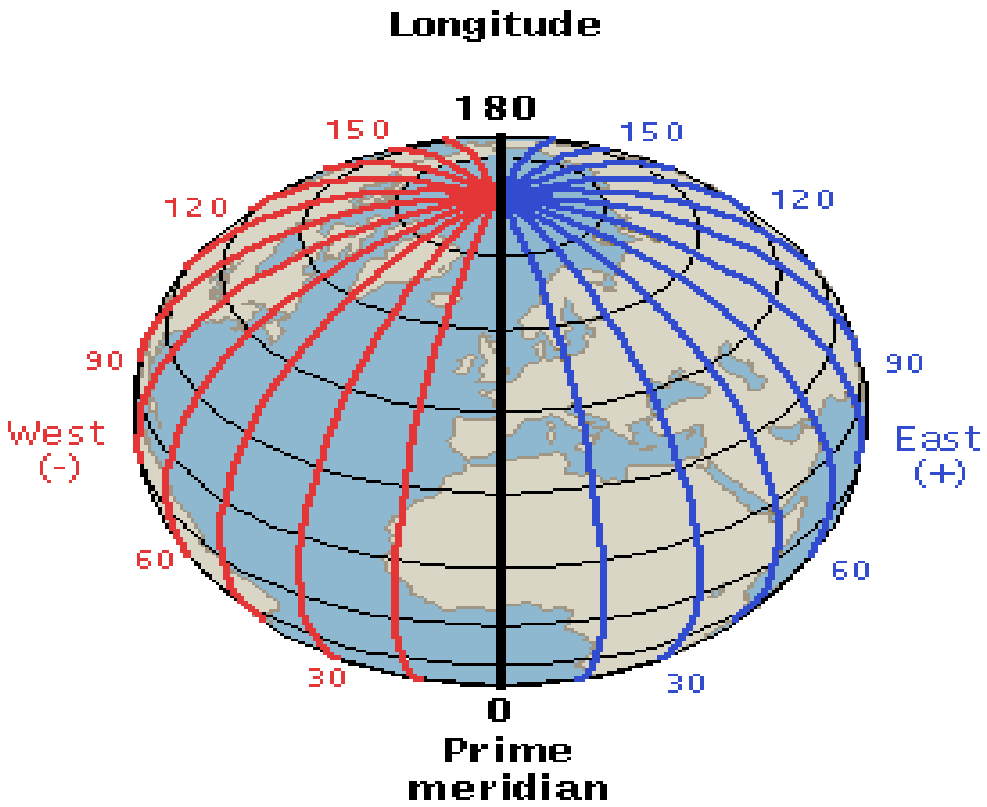


60° E is the 60° line of longitude east of the Prime Meridian.

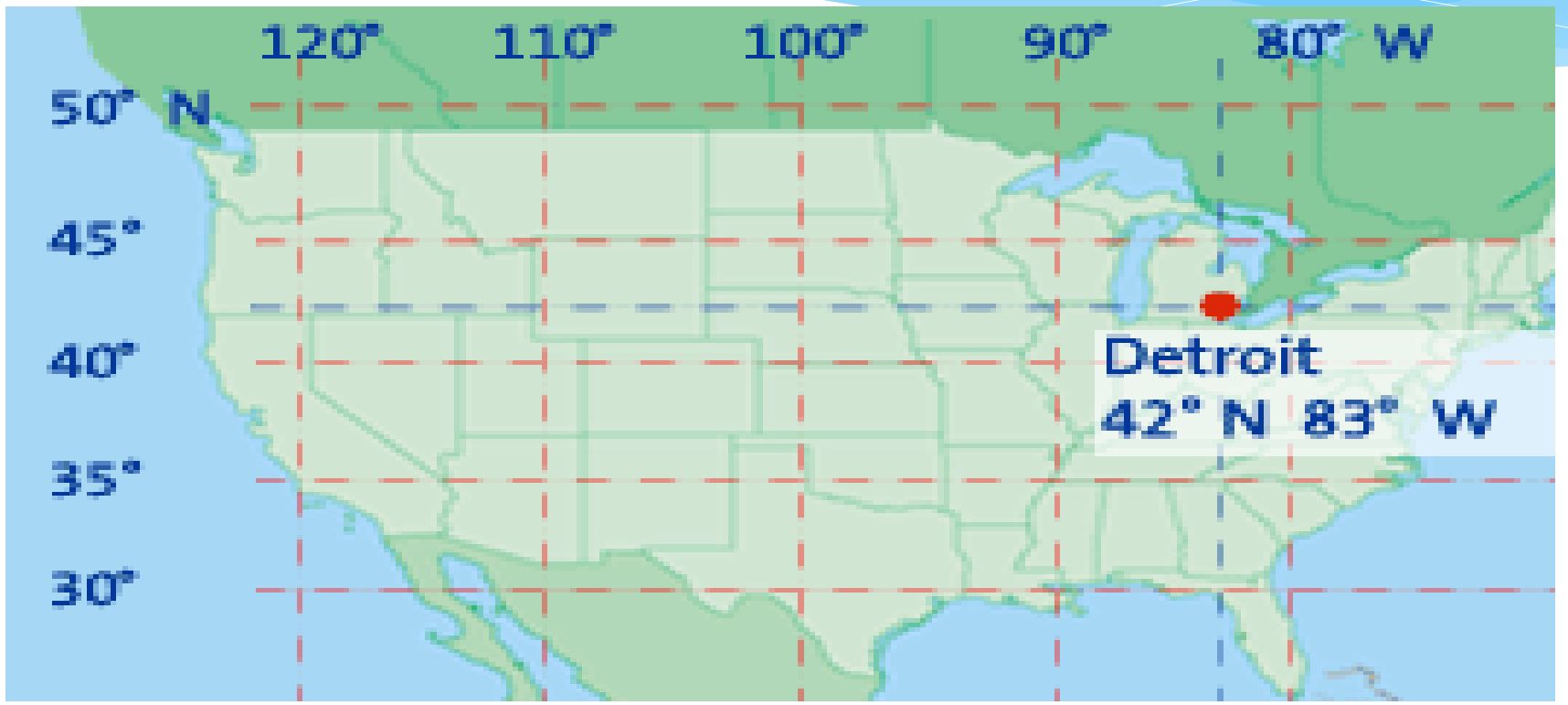
The Prime Meridian is located at 0°. It is neither east or west

By combining latitude and longitude, any location can be pinpointed



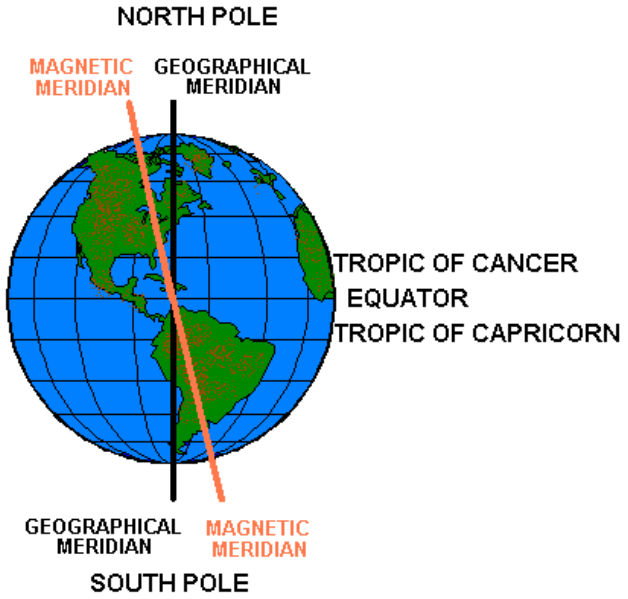


A location's coordinates
(____° N or S, ____° E or W)



Magnetic north Vs. Geographic north

The Earth rotates or spins on its axis, and the two ends of the axis are the geographic poles, North and South - known as True North and True South.



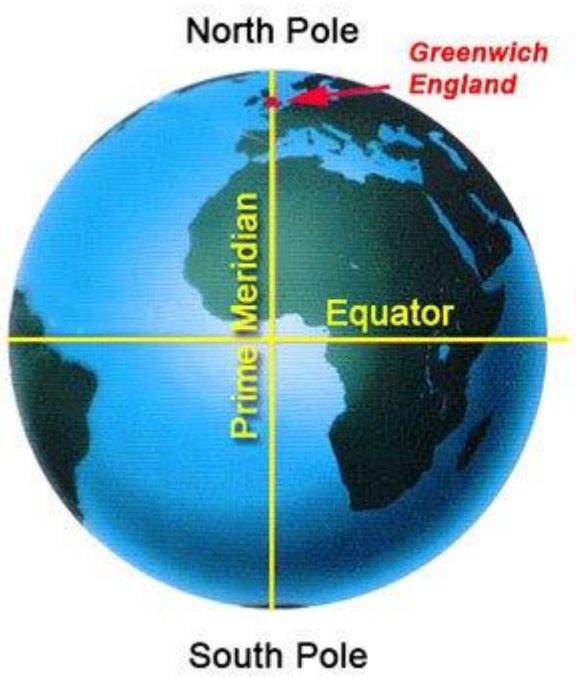
The earth acts as a giant magnet with North and South poles, but these points are not exactly where the axis of rotation - or the true north and south is, so there is a difference between the two - at the poles

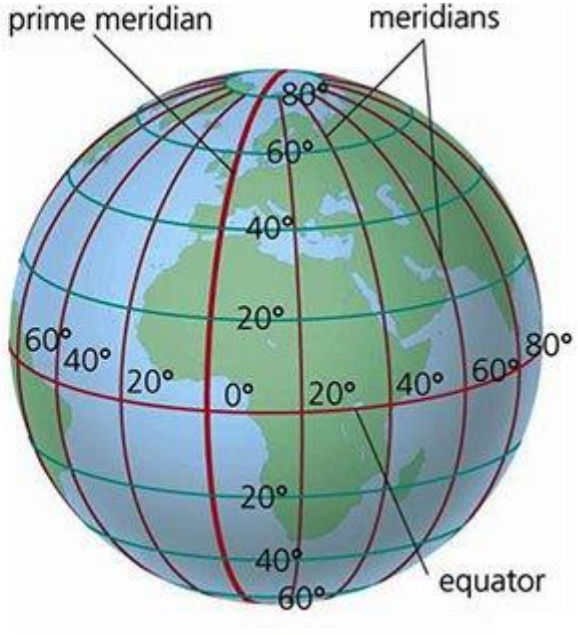
Meridians

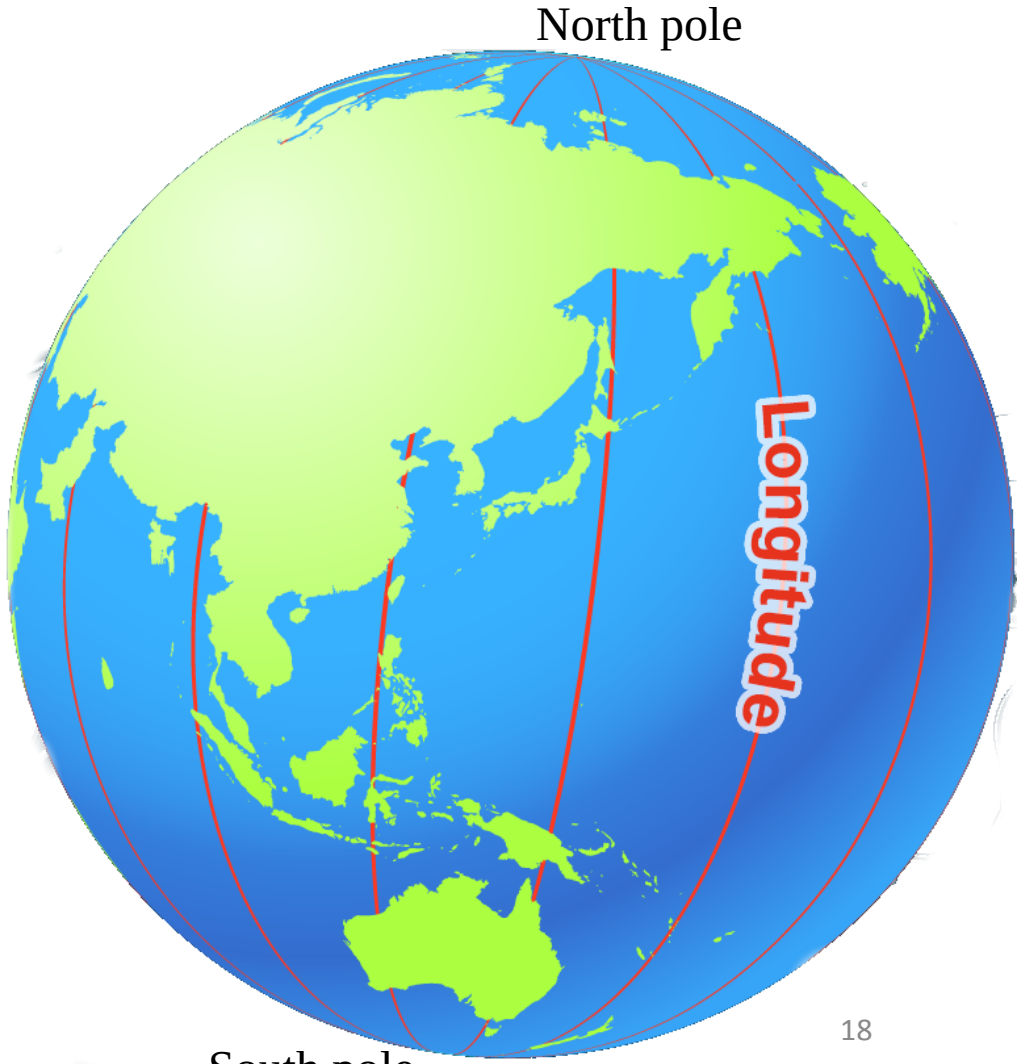
A line on the mean surface of the Earth joining the north and south poles is called a **meridian**.

All lines of longitude are meridians.

- **Geographic meridians** (also known as meridians of longitude), which all converge to meet at the pole.

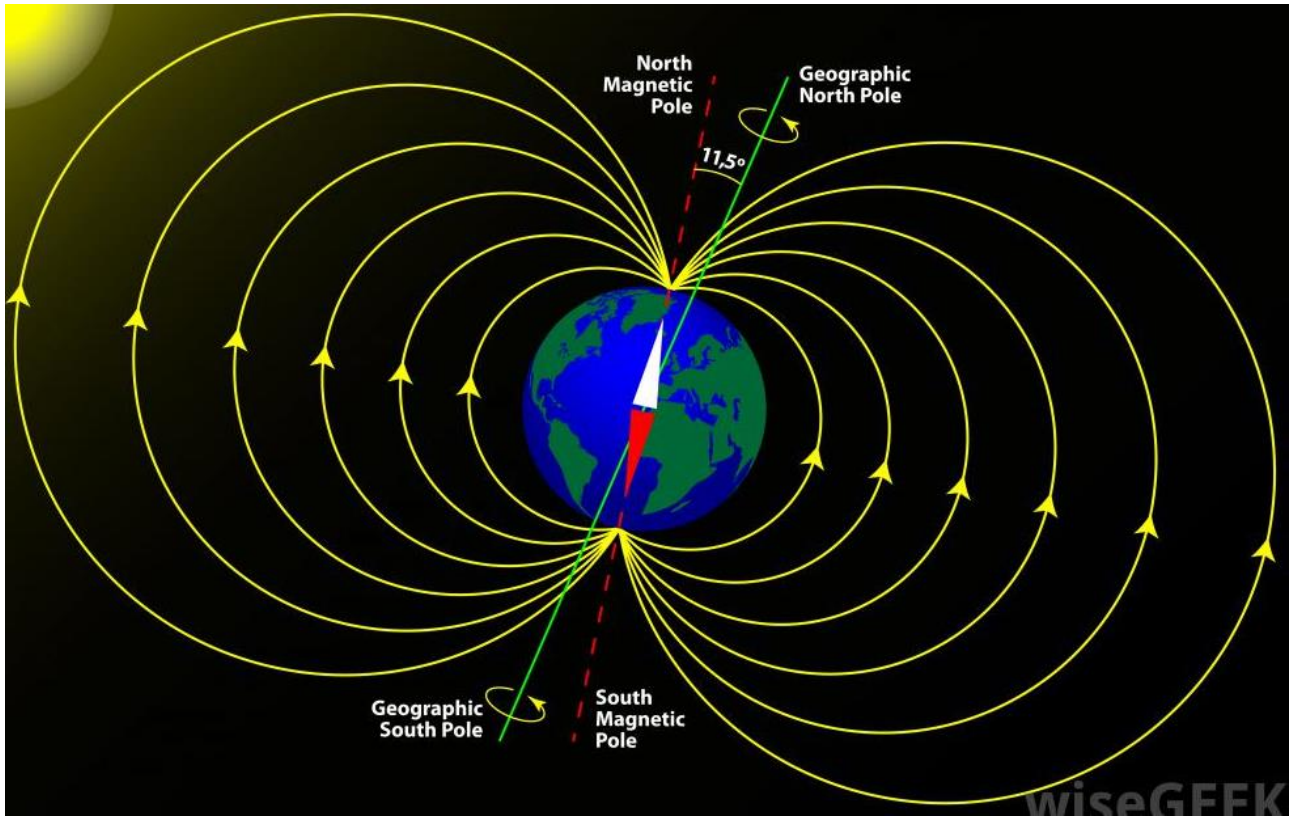


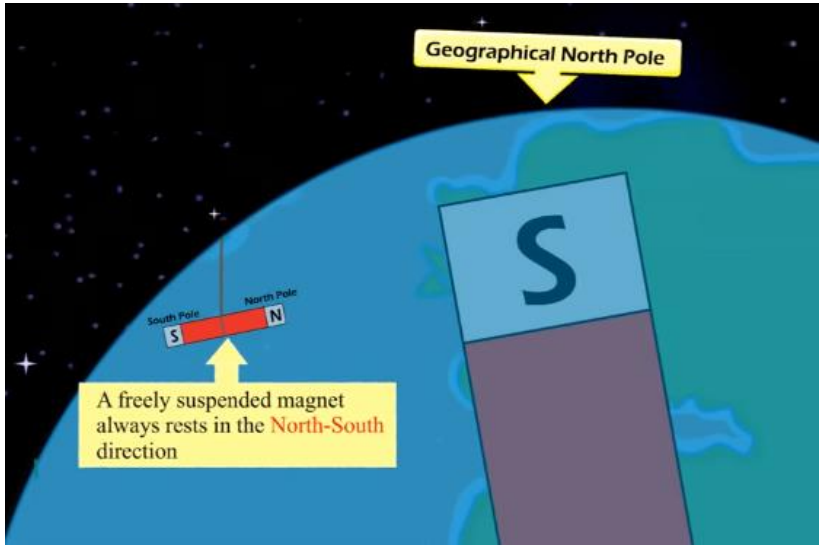




Meridians

- **Magnetic meridians** are parallel to the directions taken by freely moving magnetized needles, as in a compass.

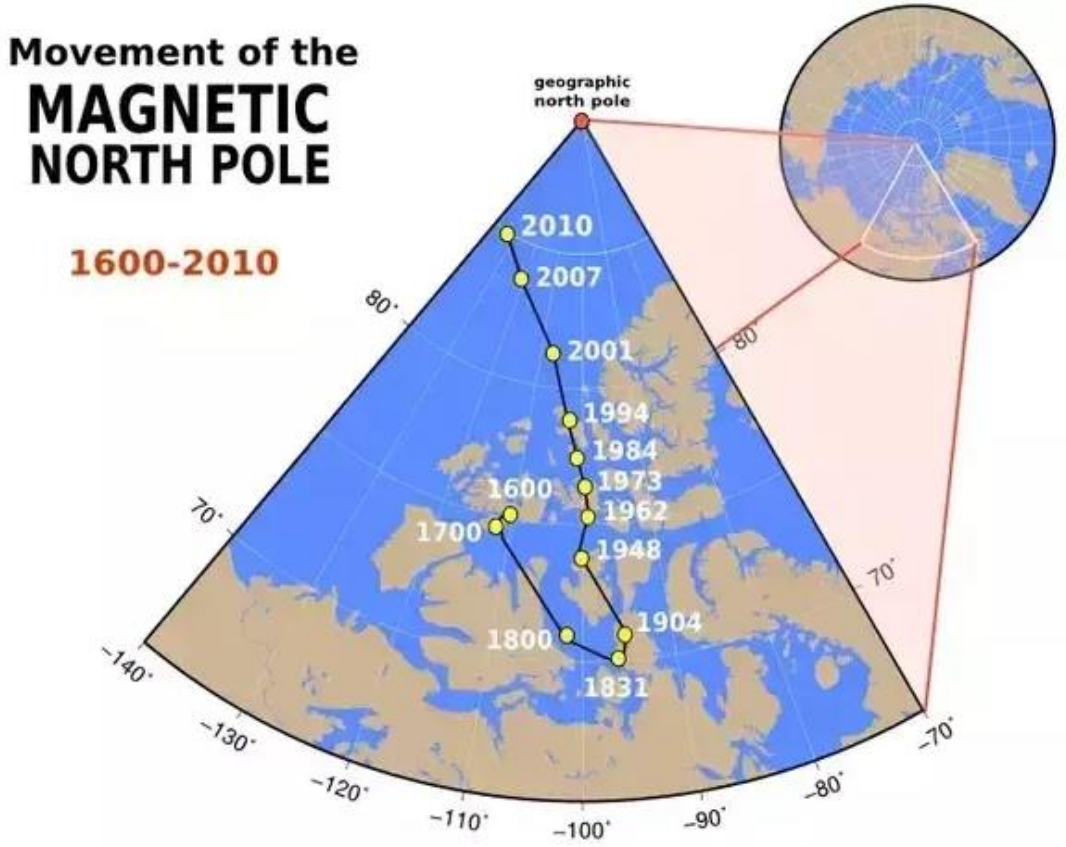




- Whereas **geographic meridians** are fixed, **magnetic meridians** vary with time and location.

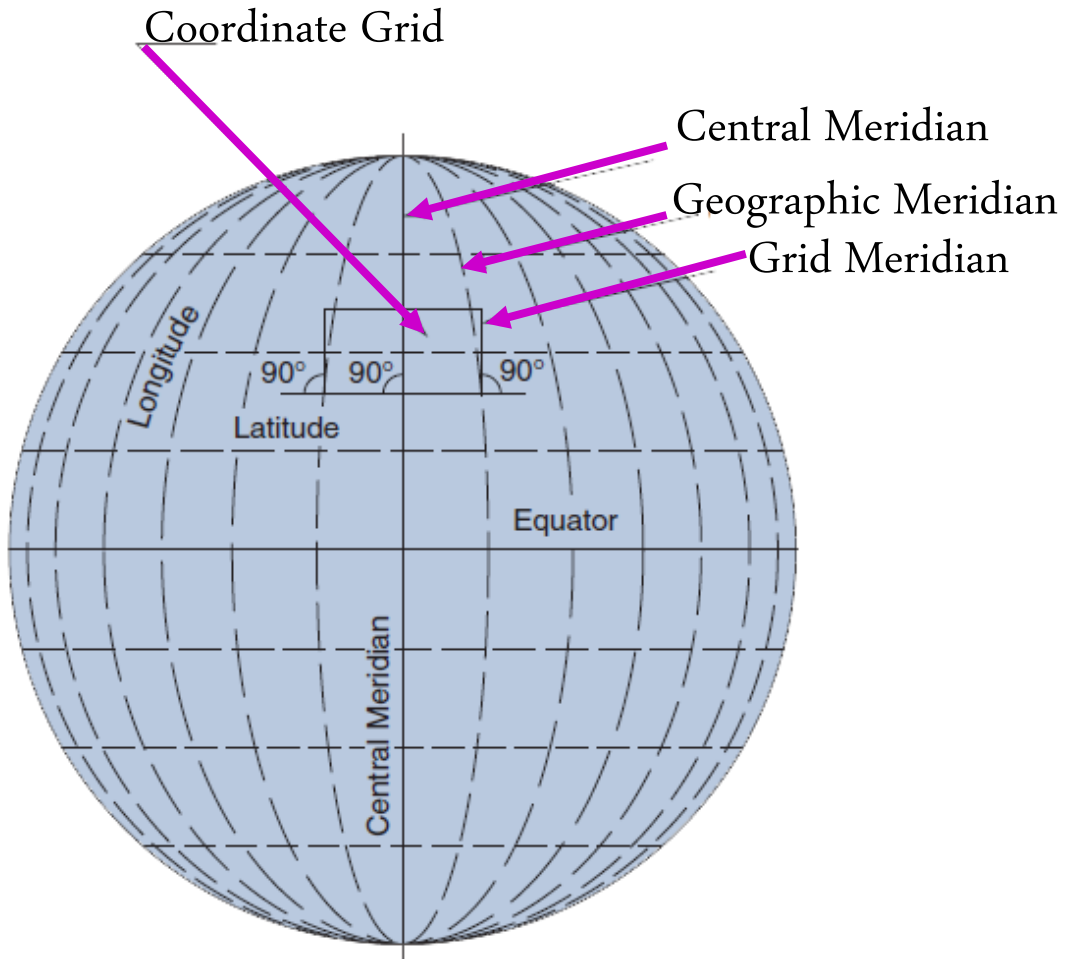
Meridians

- Whereas **geographic meridians** are fixed, **magnetic meridians** vary with time and location.



Meridians

- **Grid meridians** are lines that are parallel to a grid reference meridian (central meridian).



- **An assumed meridian** can be established by merely assigning any **arbitrary direction**—for example, taking a certain street line to be north. The directions of all other lines are then found in relation to it.

Meridians

Geographic meridians are the lines formed by the intersection with the earth's surface of a plane that includes the earth's axis of rotation.

Magnetic meridians are parallel to the directions taken by freely moving magnetized needles, as in a compass.

Grid meridians are lines that are parallel to a grid reference meridian (central meridian).

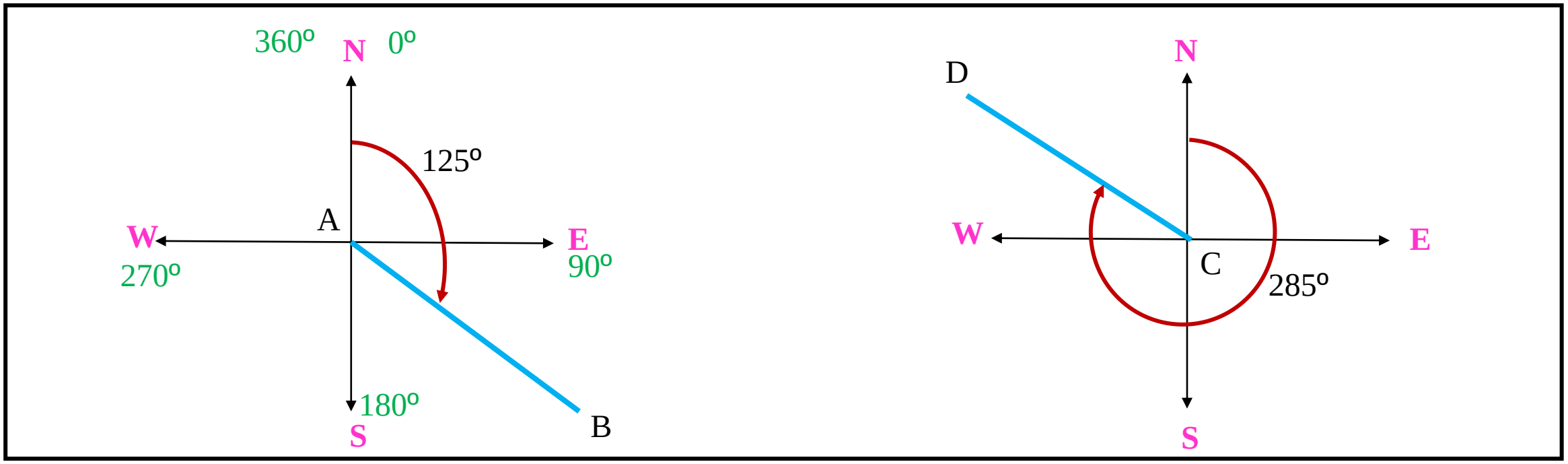
An assumed meridian can be established by merely assigning any **arbitrary direction**—for example, taking a certain street line to be north. The directions of all other lines are then found in relation to it.

Directions of A Line

The direction of any line may be described either by its *azimuth* angle or by its *bearing.*

I. AZIMUTH :

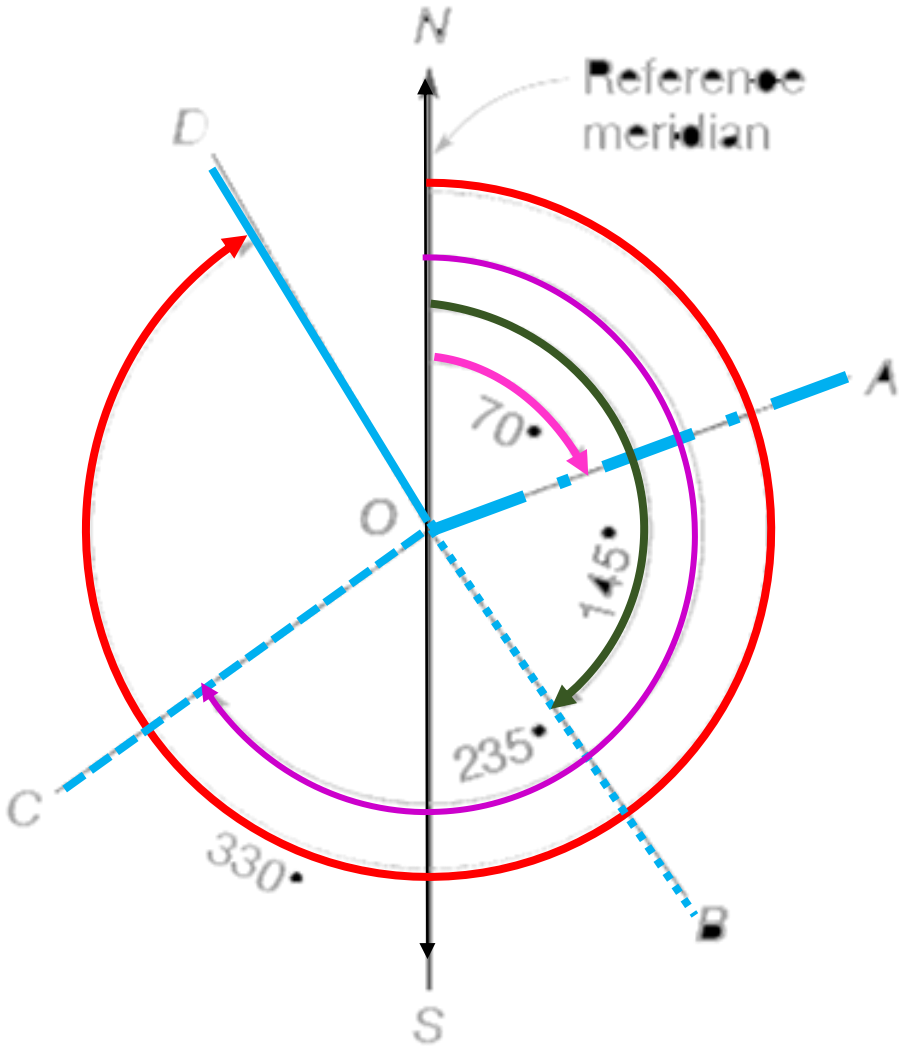
The azimuth of a line is the *clockwise* horizontal angle between the line and a given reference direction or meridian and range from 0° to 360. Usually, **north** is the reference direction.



Azimuth directions are usually preferred by surveyors; they are purely numerical and help to simplify office work by allowing a simple routine for computations.

Directions of A Line

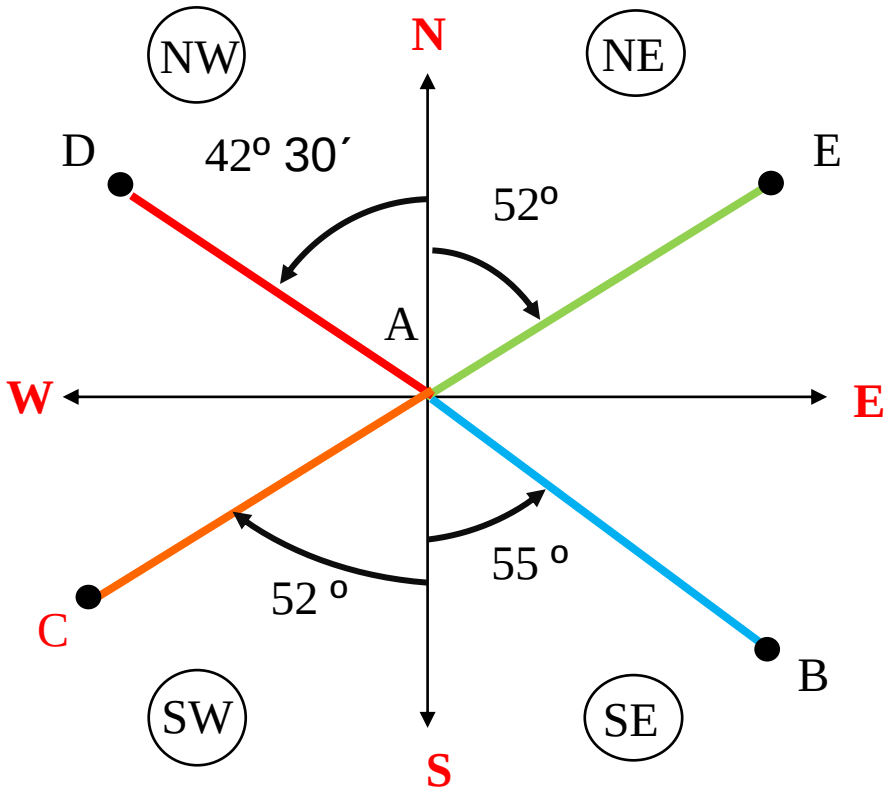
I. AZIMUTH :



Directions of A Line

II. Bearing :

A bearing of a line is the angle from the north (**N**) or the south (**S**) end of the meridian, whichever is nearest, to the line; it has the added designation of east (**E**) or west (**W**), whichever applies.

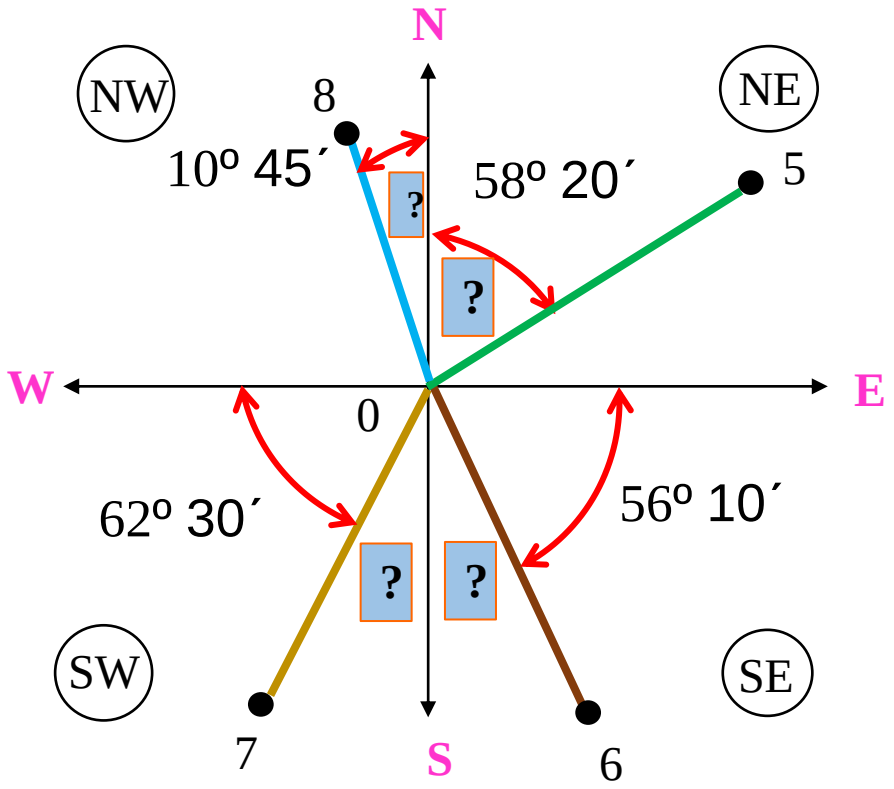


The bearing angle, is always accompanied by letters that locate the quadrant in which the line falls (NE, NW, SE, or SW).

Line	Bearing
AB	S 52º E
AC	S 52 º W
AD	N 42º 30´ W
AE	N 52º E

Directions of A Line

II. Bearing :



Line	Bearing
0 – 5	N 58º 20´ E
0 – 6	S 24º 50´ E
0 – 7	S 27º 30´ W
0 – 8	N 10º 45´ W

Comparison of Azimuths and Bearings

Bearings are readily computed from azimuths by noting the quadrant in which the azimuth falls,

Azimuths	Bearings
Vary from 0 to 360°	Vary from 0 to 90°
Require only a numerical value	Require two letters and a numerical value
Are measured clockwise only	Are measured clockwise and counterclockwise
Are measured from north only	Are measured from north and south

Relationships between bearings and azimuths

To convert from azimuths to bearings, first, determine the proper quadrant letters

Quadrant	Formulas for computing bearing angles from azimuths
I (NE)	Bearing = Azimuth
II (SE)	Bearing = 180 - Azimuth
III (SW)	Bearing = Azimuth - 180
IV (NW)	Bearing = 360 - Azimuth

Relationships between bearings and azimuths

Example directions for lines in the four quadrants (azimuths from north)

Azimuth	Bearing
54 °	N54°E
112 °	S68°E
231°	S51°W
345 °	N15°W

Relationships between bearings and azimuths

Example (1):

The azimuth of a boundary line is 128º 13´ 46´´. Convert this to a bearing.

Solution:

The azimuth places the line in the southeast quadrant.

Thus, the bearing angle is $\mathbf{180^o} - 128^o\ 13'\ 46'' = 51^o\ 46'\ 14''$

and the equivalent bearing is S 51º 46´ 14´´ E.

Relationships between bearings and azimuths

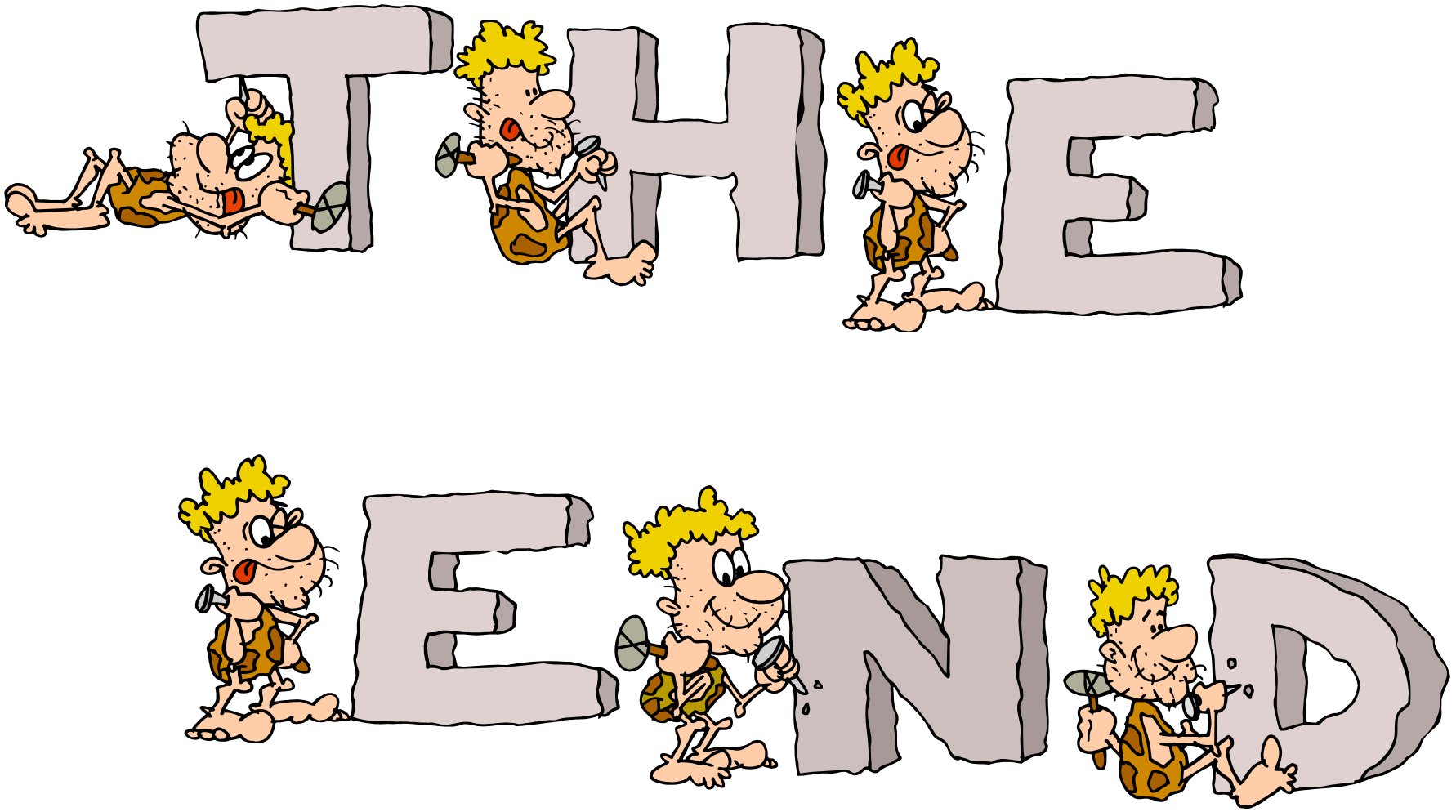
Example (2):

The first route of a boundary survey is written as N 37º 13´ W. What is its equivalent **azimuth**?

Solution:

Since the bearing is in the northwest quadrant, the azimuth is

$$360º - 37º\ 13´ = \underline{\quad 322º\ 47´ \quad}$$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